

**CLAIMS**

**What is claimed is:**

- 1           1. A method of making a catheter, comprising the steps of:  
2           winding a filament onto a core member while rotating the core member relative to  
3           a filament source and passing the filament source in a first direction of axial movement  
4           relative to the core member; and  
5           reversing a direction of axial movement of the filament source while continuing to  
6           wind the filament onto the core member, whereby the filament is continuously wound  
7           onto the core member to form a first fibrous layer as the filament source is moved relative  
8           to the core member from a first axial position to a second axial position and then back to  
9           the first axial position.
- 1           2. The method of making a catheter according to claim 1, further comprising the  
2           step of anchoring the filament at or near a proximal end of the core member before  
3           winding the filament onto the core member.
- 1           3. The method of making a catheter according to claim 2, wherein the filament is  
2           wound onto the core member continuously from the proximal end of the core member to  
3           a distal end thereof and then back to the proximal end.
- 1           4. The method of making a catheter according to claim 3, wherein the step of  
2           winding the filament onto the core member comprises winding the filament with a

3 variable pitch along a length of the core member such that a filament spacing at the distal  
4 end of the core member is narrower than a filament spacing at the proximal end of the  
5 core member.

1 5. The method of making a catheter according to claim 1, wherein the core  
2 member is a mandrel on which the catheter is formed.

1 6. The method of making a catheter according to claim 1, wherein the core  
2 member is a substrate that forms an inner lining of the catheter.

1 7. The method of making a catheter according to claim 1, wherein the filament  
2 source is a filament spool.

1 8. The method of making a catheter according to claim 1, wherein the step of  
2 winding the filament onto the core member comprises winding the filament with a  
3 constant pitch along a length of the core member.

1 9. The method of making a catheter according to claim 1, wherein the step of  
2 winding the filament onto the core member comprises winding the filament with a varied  
3 pitch along a length of the core member.

1 10. The method of making a catheter according to claim 1, further comprising the

2 step of winding at least one additional layer of filament over said first fibrous layer to  
3 form at least one additional fibrous layer.

1 11. The method of making a catheter according to claim 10, wherein said step of  
2 winding at least one additional layer of filament comprises continuously winding the  
3 filament over the first fibrous layer as the filament source is moved axially along the core  
4 member from a proximal position to a distal position and then back to the proximal  
5 position.

1 12. The method of making a catheter according to claim 11, wherein said  
2 proximal position is at a proximal end of the core member and said distal position is  
3 between the proximal end and a distal end of the core member.

1 13. The method of making a catheter according to claim 12, wherein said at least  
2 one additional fibrous layer comprises a plurality of additional fibrous layers, and wherein  
3 said plurality of additional fibrous layers extend to different distal positions along the  
4 core member, whereby the first and additional fibrous layers form a catheter having a  
5 tapering profile and variable properties along its length.

1 14. The method of making a catheter according to claim 12, further comprising  
2 the step of placing a marker band at a distal end of at least one of said fibrous layers.

1           15. The method of making a catheter according to claim 14, wherein said step of  
2           placing a marker band comprises placing marker bands at the distal ends of a plurality of  
3           said fibrous layers.

1           16. The method of making a catheter according to claim 14, wherein said marker  
2           band has a wall thickness approximately equal to a thickness of said distal end of the  
3           fibrous layer.

1           17. The method of making a catheter according to claim 1, further comprising the  
2           step of coating the core member and fibrous layer with plastic.

1           18. The method of making a catheter according to claim 17, wherein said step of  
2           coating with plastic comprises applying a polymer material in a particulate preform over  
3           an outer surface of the core member and the fibrous layer.

1           19. The method of making a catheter according to claim 17, wherein said step of  
2           coating with plastic comprises laminating a plastic tube over an outer surface of the core  
3           member and the fibrous layer.

1           20. The method of making a catheter according to claim 17, wherein said step of  
2           coating with plastic comprises extruding a plastic material over an outer surface of the  
3           core member and the fibrous layer.

1           21. The method of making a catheter according to claim 17, wherein said step of  
2           coating with plastic comprises applying a molecular strand of plastic material over an  
3           outer surface of the core member and the fibrous layer using electrostatic forces.

1           22. The method of making a catheter according to claim 1, wherein said step of  
2           winding a filament comprises winding a group of filaments simultaneously.

1           23. The method of making a catheter according to claim 22, wherein said group  
2           of filaments are wound with a constant spacing between the filaments within the group.

1           24. The method of making a catheter according to claim 22, wherein said group  
2           of filaments are wound with a variable pitch such that a filament group spacing at a distal  
3           end of the core member is narrower than a filament group spacing at a proximal end of  
4           the core member.

1           25. The method of making a catheter according to claim 22, wherein said group  
2           of filaments are wound with a variable spacing between the filaments within the group  
3           such that a filament spacing at a distal end of the core member is narrower than a filament  
4           spacing at a proximal end of the core member.

1           26. The method of making a catheter according to claim 25, wherein said group

2 of filaments are wound with a variable pitch and a variable spacing between the filaments  
3 within the filament group.

1 27. The method of making a catheter according to claim 22, further comprising  
2 the step of using wire guides to control the filament spacing within the group of  
3 filaments, and varying a spacing between the wire guides as the winding proceeds along a  
4 length of the core member.

1 28. The method of making a catheter according to claim 22, further comprising  
2 the step of providing a guide assembly having a filament engaging surface, and arranging  
3 said guide assembly such that the filament engaging surface lies in a plane which is  
4 generally perpendicular to a longitudinal axis of the core member, whereby the guide  
5 assembly causes the filaments within said group of filaments to be positioned side-by-  
6 side and packed tightly against one another as the group of filaments are wound onto the  
7 core member.

1 29. The method of making a catheter according to claim 28, further comprising  
2 the step of varying a rotation speed of the core member or a translation speed of the  
3 filament source along the core member to vary a pitch of the group of filaments being  
4 wound onto the core member.

1 30. A method of making a catheter, comprising the step of winding a group of

2       filaments simultaneously onto a core member while rotating the core member relative to a  
3       source of said filaments and passing the source of filaments in a first direction of axial  
4       movement relative to the core member.

1               31. The method of making a catheter according to claim 30, further comprising  
2       the step of varying a rotation speed of the core member or a translation speed of the  
3       source of filaments along the core member to vary a pitch of the group of filaments being  
4       wound onto the core member.

1               32. The method of making a catheter according to claim 30, wherein said group  
2       of filaments are wound with a variable pitch such that a filament group spacing at a distal  
3       end of the core member is narrower than a filament group spacing at a proximal end of  
4       the core member.

1               33. The method of making a catheter according to claim 30, wherein said group  
2       of filaments are wound with a variable spacing between the filaments within the group  
3       such that a filament spacing at a distal end of the core member is narrower than a filament  
4       spacing at a proximal end of the core member.

1               34. The method of making a catheter according to claim 30, wherein said group  
2       of filaments are wound with a variable pitch and a variable spacing between the filaments  
3       within the filament group.

1           35. The method of making a catheter according to claim 30, further comprising  
2           the step of using wire guides to control the filament spacing within the group of  
3           filaments, and varying a spacing between the wire guides as the winding proceeds along a  
4           length of the core member.

1           36. The method of making a catheter according to claim 30, further comprising  
2           the step of providing a guide assembly having a filament engaging surface, and arranging  
3           said guide assembly such that the filament engaging surface lies in a plane which is  
4           generally perpendicular to a longitudinal axis of the core member, whereby the guide  
5           assembly causes the filaments within said group of filaments to be positioned side-by-  
6           side and packed tightly against one another as the group of filaments are wound onto the  
7           core member.

1           37. The method of making a catheter according to claim 30, further comprising  
2           the step of reversing a direction of axial movement of the source of filaments relative to  
3           the core member while continuing to wind the group of filaments onto the core member,  
4           whereby the filaments are continuously wound onto the core member as the source of  
5           filaments is moved relative to the core member from a first axial position to a second  
6           axial position and then back to the first axial position.



1           38. A catheter having a proximal end, a distal end, and a lumen extending  
2           between said proximal and distal ends, said catheter comprising:  
3           a fibrous reinforcement layer in a wall of said catheter, said fibrous layer  
4           comprising a continuous filament having first and second ends and a series of windings  
5           formed between said first and second ends, said first end of said filament being anchored  
6           in the proximal end of the catheter, said windings extending from the proximal end to the  
7           distal end of the catheter and then back to the proximal end, and said second end of said  
8           filament being anchored in the proximal end.

1           39. The catheter according to claim 38, further comprising a substrate, and said  
2           fibrous reinforcement layer is disposed on an outer surface of said substrate.

1           40. The catheter according to claim 38, further comprising a plastic coating  
2           covering said fibrous reinforcement layer.

1           41. The catheter according to claim 38, wherein said windings have a variable  
2           pitch along a length of the catheter.

1           42. The catheter according to claim 38, wherein said fibrous reinforcement layer  
2           comprises a group of filaments and each filament in said group is a continuous filament  
3           with windings extending from the proximal end to the distal end and then back to the  
4           proximal end.

1           43. The catheter according to claim 42, wherein a spacing between the filaments  
2           in said group of filaments remains constant over a length of the catheter.

1           44. The catheter according to claim 42, wherein said group of filaments has a  
2           variable pitch along a length of the catheter.

1           45. The catheter according to claim 42, wherein said group of filaments has a  
2           variable pitch and the filaments within said group have a variable spacing between each  
3           other along a length of the catheter.

1           46. The catheter according to claim 42, wherein the filaments within said group  
2           of filaments are positioned side-by-side and packed tightly against one another in the  
3           windings.

1           47. A catheter having a proximal end, a distal end, and a lumen extending  
2           between the proximal and distal ends, said catheter comprising:  
3           a fibrous reinforcement layer in a wall of said catheter, said fibrous layer  
4           comprising a group of filaments which are wound around the lumen between the  
5           proximal and distal ends with a variable pitch.

1           48. The catheter according to claim 47, wherein the filaments within said group

2 of filaments have a variable spacing between each other along a length of the catheter.

1 49. The catheter according to claim 47, wherein the filaments within said group  
2 of filaments are positioned side-by-side and packed tightly against one another.